

APPENDIX E

INTERACTION DIAGRAM

E-1. Introduction

A complete discussion on the construction of interaction diagrams is beyond the scope of this manual; however, in order to demonstrate how the equations presented in Chapter 4 may be used to construct a diagram a few basic points will be computed. Note that the effects of ϕ , the strength reduction factor, have not been considered. Using the example cross section shown below compute the points defined by 1, 2, 3 notations shown in Figure E-1.

Given: $f'_c = 3.0 \text{ ksi}$

$f_y = 60 \text{ ksi}$

$A_s = 2.0 \text{ sq in.}$

$d = 22 \text{ in.}$

$h = 24 \text{ in.}$

$b = 12 \text{ in.}$

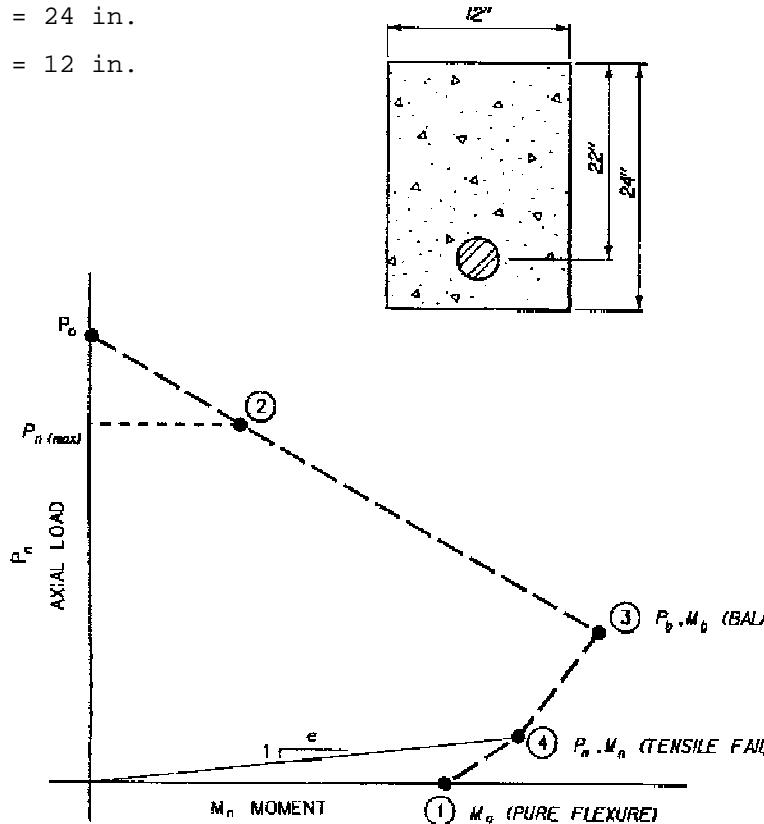
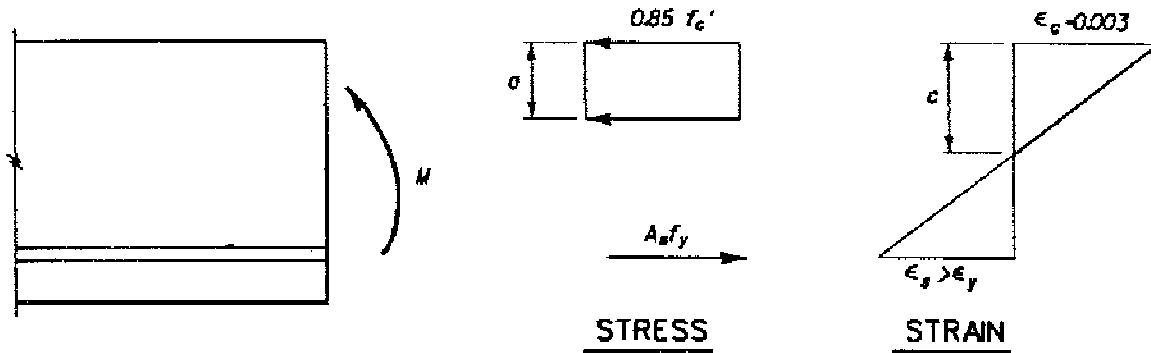


Figure E-1. Interaction diagram

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E-2. Determination of Point 1, Pure Flexure



$$\phi M_n = \phi 0.85 f_c' ab(d - a/2)$$

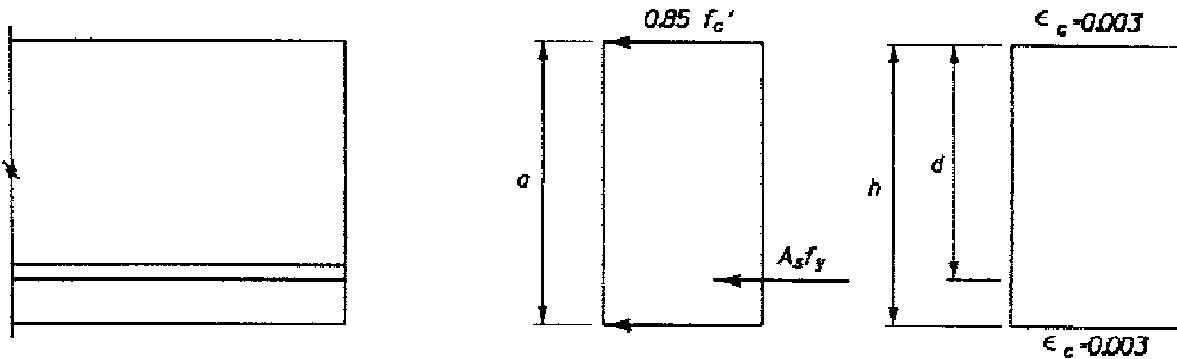
$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{(2.0)(60.0)}{(0.85)(3.0)(12)} = 3.922 \text{ in.}$$

$$M_n = (0.85)(3.0)(3.922)(12)(22 - 1.961) \quad (\text{D-5})$$

$$M_n = 2404.7 \text{ k-in.}$$

$$M_n = 200.4 \text{ k-ft}$$

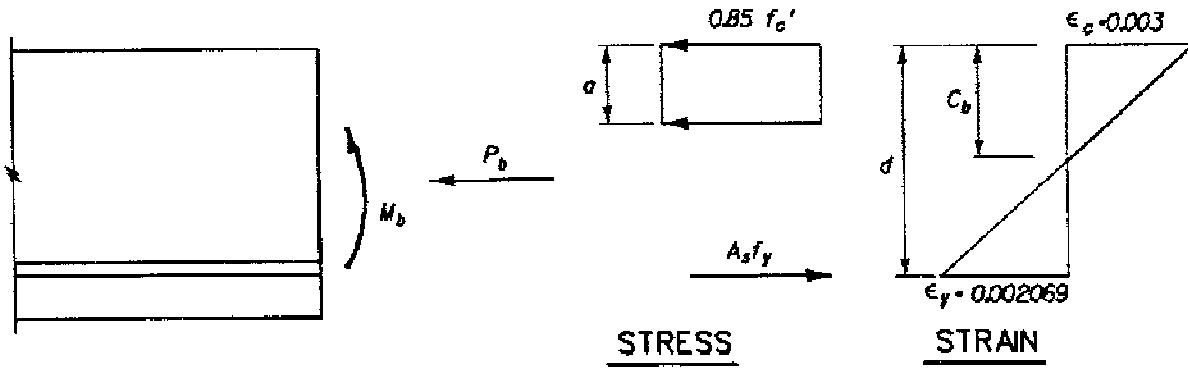
E-3. Determination of Point 2, Maximum Axial Capacity



$$\phi P_{n(\max)} = \phi 0.80 P_o$$

$$\begin{aligned}\phi P_{n(\max)} &= \phi 0.80 [0.85 f'_c (A_g - \rho bd) + f_y \rho bd] \\ P_{n(\max)} &= 0.80[(0.85)(3.0)(288 - 2.0) + (60.0)(2.0)] \\ P_{n(\max)} &= 0.80(849.3) = 679.44 \text{ kips}\end{aligned}\quad (4-2)$$

E-4. Determination of Point 3, Balanced Point



$$(1) \text{ Find } k_b = \frac{\beta_1 E_s \epsilon_c}{E_s \epsilon_c + f_y} \quad (4-4)$$

$$k_b = \frac{(0.85)(29,000)(0.003)}{(29,000)(0.003) + 60} = 0.5031$$

$$(2) \text{ Find } \frac{e_b'}{d} = \frac{2k_u - k_u^2}{2k_u - \frac{pf_y}{0.425f_c}} \quad (4-3)$$

$$\frac{e_b'}{d} = \frac{(2)(0.5031) - (0.5031)^2}{(2)(0.5031) - \frac{(0.00758)(60)}{(0.425)(3.0)}} = 1.15951$$

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(3) Find $\phi P_b = \phi [0.85 f'_c k_b - \rho f_y] bd$

$$P_b = [(0.85)(3.0)(0.5031) - (0.00758)(60.0)](12)(22.0)$$

$$P_b = 218.62 \text{ kips}$$

(4) Find $\phi M_b = \phi [0.85 f'_c k_b - \rho f_y] \left[\frac{e'}{d} - \left(1 - \frac{h}{2d}\right) \right] bd^2$

$$M_b = [(0.85)(3.0)(0.5031) - (0.00758)(60)] \cdot$$

$$[1.15951 - (1 - 24.0/44.0)](12)(22.0)^2$$

(4-6)

$$M_b = 3390.65 \text{ k-in.}$$

$$M_b = 282.55 \text{ k-ft}$$

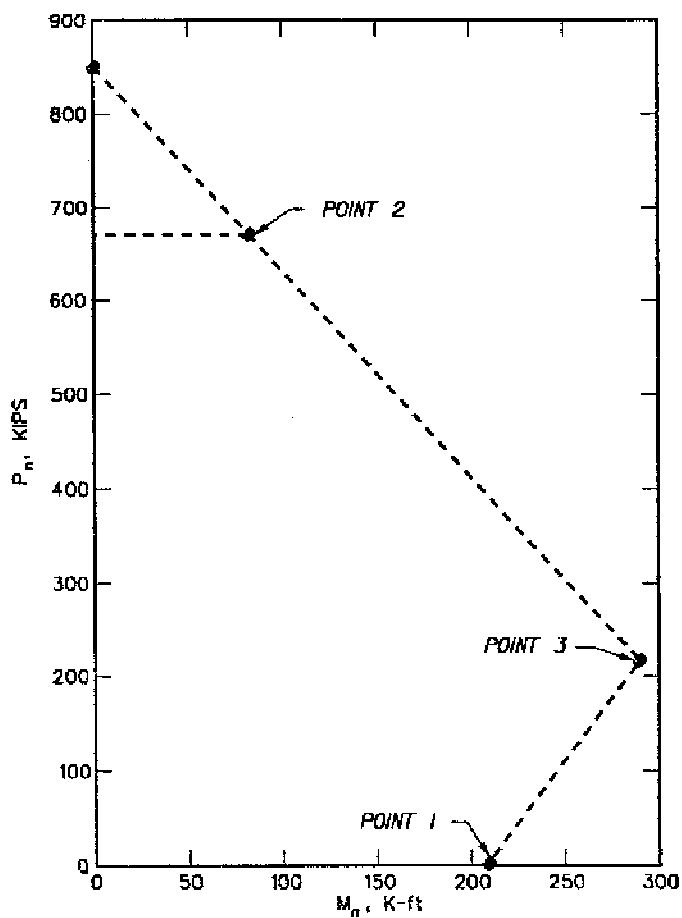


Figure E-2. Interaction diagram solution